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### (54) METHOD OF CLEANING MEMBRANE MODULES

VERFAHREN ZUR REINIGUNG VON MEMBRANMODULEN

PROCEDE DE NETTOYAGE DE MODULES MEMBRANAIRES

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- **DATABASE WPI Week 198511, Derwent Publications Ltd., London, GB; Class J01, AN 1985-064514, XP002990491 & JP 60 019 002 A (NIPPON GENSIRYOKU JIGYO) 31 January 1985**
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## Description

**[0001]** The present invention relates to a method of cleaning a membrane filtration module according to the preamble of claim 1. The present invention especially relates to a method for improving the filtration efficiency of a filtration system by providing an improved cleaning system for the membranes.

**[0002]** A method of cleaning the membrane filtration module is described in WO 00/30742. This document describes a process of water filtration including cleaning operations on the membrane wall to dislodge containment therefrom. The cleaning operations include air scouring provided by blowing air (or other suitable gases) through air distribution pipes to an aerator arranged below the membrane module. The aerator disperses scouring bubbles which rise through the membrane module and discourage solids from depositing on the membranes.

**[0003]** The cleaning process further includes backwashing by means of filtered permeate pushed back in a reverse direction through the walls of the membranes. Moreover, a chemical cleaning is performed.

**[0004]** The cleaning operations are performed typically during a filtration process while the filtration process is only stopped momentarily, and the filtering process is considered to be continuous. Thus, the dislodged containment matter is removed during the usual filtration process.

**[0005]** WO 96/07470 discloses a method of cleaning a membrane filtration module comprising suspending the filtration operation, performing a cleaning operation on the membrane wall to dislodge contaminant matter therefrom into liquid surrounding the membrane by applying a source of fluid to the permeate side of the membranes, at the same time, or just after opening the vessel to atmosphere, to cause explosive decompression through the walls of the membranes whereby the fluid under pressure passes through said walls.

**[0006]** Maruyama et al in Japanese Patent No. JP2031200 discloses a hollow fibre membrane backwashing method. The method involves the following sequence: stop filtration, air-scour membrane, fill the membrane vessel, backwash with permeate under pressurized air and drain waste. This procedure is repeated to achieve a higher efficiency. Sunaoka et al in a United States Patent No. 5,209,852 describes a process for scrubbing hollow fibre membranes in modules. This process is composed of a two-stage air scrubbing and draining to clean the membranes.

**[0007]** A lot of effort has been made to more effectively lift solids accumulated on the membrane surface and in the pores by optimising the backwash pressure and enhancing the air scrubbing efficiency. Another important step to achieve an efficient cleaning, which has been largely ignored, is the removal of solids that have been exfoliated off the membrane, from the membrane modules. The typical methods presently used are by draining

down of the waste or by feed-and-bleed. Feed and bleed involves continual bleeding of waste containing feed out of the filtration system. The outcome is the accumulation of solids within the modules, particularly towards the two ends of a module and the effect becomes more serious if the membranes are densely packed in a module.

## DISCLOSURE OF THE INVENTION

**[0008]** It is an object of the present invention to overcome or at least ameliorate one or more of the disadvantages of the prior art outlined above or at least provided a useful alternative.

**[0009]** Accordingly, the present invention provides in a first aspect a method of cleaning a membrane filtration module including the features of claim 1.

**[0010]** A second aspect of the invention is recited in independent claim 4.

**[0011]** The contaminant matter may include solids, soluble species or other material removed from the feed during the filtration process.

## BRIEF DESCRIPTION OF DRAWINGS

**[0012]** Preferred embodiments and examples of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a schematic representation of the membrane module assembly according to one embodiment of the invention;

Figures 2a to 2d show schematic representations of the membrane module of Figure 1 during the membrane cleaning sequence according to the invention; Figure 3 shows a graph of transmembrane pressure (TMP) versus time for the module of Figure 1 illustrating cleaning efficiencies of various backwash regimes;

Figure 4 shows a graph of transmembrane pressure (TMP) versus time for the module of Figure 1 illustrating the effect of the high velocity sweep on membrane cleaning;

Figure 5 shows a schematic representation of a membrane module according to a further embodiment of the present invention; and

Figure 6 shows a graph of transmembrane pressure (TMP) versus time for the module of Figure 5 illustrating the effect of the gas injection on scrubbing efficiency.

## DESCRIPTION OF PREFERRED EMBODIMENTS AND EXAMPLES

**[0013]** In the preferred embodiments, the membrane cleaning regime may include a combination, in part or in whole, depending on the feed water quality, of one or more backwash methods.

**[0014]** A backwash or blowout, or a combination of

both, may be used to dislodge the solids blocking the membrane pores.

**[0015]** The backwash is normally achieved by forcing the permeate in a reverse direction to filtration through the membrane pores. The backwash flow rate is usually in a range of 50 - 500% of the filtration flow, more commonly in a range of 100 - 300% of the filtration flow.

**[0016]** Blowout is another method of removing solids from the membrane pores by creating a rapid and explosive decompression within the filtration vessel. In this method, the two sides (feed side and permeate side) of a membrane are firstly pressurized to a specific value. Then the discharge valve on the feed side is opened to generate an instantaneous negative transmembrane pressure (TMP). The solids in membrane pores are then blown out by the instantaneous negative TMP. As described below, in one embodiment, the blowout can also be integrated into a high velocity sweep step.

**[0017]** Another method of removing solids build-up from the membrane walls uses gas scouring to exfoliate the membrane surface. This method uses gas bubbles moving past the membrane surface to achieve an efficient scrubbing. Gas scouring is widely used in the membrane filtration processes where suction is applied to the permeate side of the membrane wall to induce filtration. For the pressurized membrane filtration systems, gas scrubbing is achieved by injecting gas, usually air, into the bottom end of the membrane module while the permeate is withdrawn from the upper end, as described in Japanese Patent No. JP2031200 and United States Patent No. 5,209,852.

**[0018]** After the backwash step, the solids removed from the membranes are normally removed from modules by draindown of the waste. The velocity during a normal draindown is limited by the gravity force on the liquid within the vessel. The shear force thus generated is weak and may not be high enough to flush accumulated solids out of the modules and/or strip solids off the surface of the membrane. The situation is more manifest in hollow fibre membrane modules having a high fibre packing density.

**[0019]** Referring to Figures 1 and 2, a preferred embodiment of one form of module cleaning will be described.

**[0020]** Figure 1 illustrates a membrane module assembly 5. A hollow fibre membrane module 6 is located in a vessel 7. The module 6, in this example, contains a plurality of porous hollow fibre membranes 8, the ends of the fibres opening into respective upper and lower permeate collection headers 9 and 10. Filtration takes place by applying feed to the outer wall of the fibres and withdrawing permeate through the fibre lumens. Filtrate/permeate is removed from both ends of the module 6 through ports 11 and 12 connected to headers 9 and 10 respectively. Feed inlet ports 13 and 14 and waste discharge ports 15 and 16 are provided at the upper and lower ends of the vessel 7, respectively.

**[0021]** Valves AV1 and AV2 control the flow of feed to

ports 13 and 14 while valves AV8 and AV5 control the flow of scouring gas. The flow of filtrate or permeate from the headers 9 and 10 is controlled by valves AV3 and AV4 while backwash flow to these headers is controlled by valves AV7 and AV4. Valves AV5 and AV6 control waste discharge from ports 15 and 16.

**[0022]** The steps of the process will now be described with reference to Figures 2a to 2d.

**[0023]** Step 1. Filtration. During a typical dead-end filtration process, valves AV1-4 are open. The raw feed water is fed via valves AV1 and AV2 entering the upper and lower inlet ports 13 and 14 while the permeate is withdrawn from the top and bottom ports 11 and 12 of the module 6 (as best shown in Figure 2(a)).

**[0024]** Step 2. Air scouring. At the end of the filtration step, valves AV1-4 are closed, and then the upper discharge valve AV5 and the gas inlet valve AV8 are open. Gas (usually air) is then introduced into the module 6 through valve AVB and the lower port 14 to scour the membrane as illustrated in Figure 2(b).

**[0025]** Step 3. Pressurization via backwash. When the gas scouring stops, valves AV5 and AV8 are closed. The vessel 7 is left partly filled with gas and water. A permeate backwash is initiated by opening valves AV4 and AV7. The pressure in the vessel 7 gradually increases during the backwash to pressurize the remaining gas within the vessel 7 (see Figure 2 (c)) and finally the pressure on both sides of the membrane walls equalizes. A pressurized gas pocket is thus formed within the vessel 7.

**[0026]** Another way to create such a gas pocket is to drain down or partly drain down the liquid waste at the end of the filtration Step 1 or after the gas scouring in Step 2. In this case it takes longer time to pressurize the gas, and consumes more permeate, but will achieve a higher average sweep velocity. The sweep velocity is desirably greater than 0.03m/sec and preferably in the range 0.3 m/sec to 2.0 m/sec.

**[0027]** Step 4. Blowout and high velocity sweep down (Figure 2 (d)). When the pressure on the permeate side approaches that on the feed side of the membrane wall, which is also the maximum discharge pressure of the backwash pump, valve AV6 is opened. An instantaneous negative TMP is generated across the membrane wall, which achieves a second backwash of the membrane pores. Simultaneously, the high-pressure gas pocket formed on the feed side rapidly expands and sweeps down the solids out of the membrane module at a high velocity through port 16. The high velocity sweep may also create a high shear force to assist scrubbing the membrane surface. The maximum negative TMP and sweep velocity that can be achieved depend on the resistance in the drain line and the pressure on the permeate side of the membrane. At the end of the fast drain, the backwash pump is stopped and valves AV6 and AV7 are closed. The sequence then returns to the start of filtration.

**[0028]** The process described above generates both a blowout effect and a fast drain-down of the vessel 7.

Therefore good cleaning efficiency can be achieved. Other means to achieve a high velocity sweep may include the use of the feed pump to deliver a sweep flow or employing compressed air/gas applied to the vessel housing the module or an external vessel, to achieve a high velocity sweep. An external vessel may be used where formation of a pressurized gas bubble within the feed containing vessel is difficult due to module configuration. In such an arrangement a gas containing region is provided within a further vessel coupled to said feed-containing vessel. The feed-containing vessel and the further vessel are sealed as a whole following said cleaning step and pressure applied to gas within the gas containing region to pressurize said gas, the pressure is then released by opening the feed-containing vessel to atmosphere so as to cause the pressurized gas to expand and produce said high velocity sweep of the feed-containing vessel. An external vessel may also be selectively coupled by a valve to the feed-containing vessel and contain pressurized gas and/or liquid which is released by opening the valve into the feed containing vessel to produce the high velocity sweep.

**[0029]** A further method of achieving a highly efficient sweep is to change the sweep direction (upwards and downwards sweep) from time to time. The times of the sweep in one direction and the frequency of change of the sweep direction depend on the module configuration, feed water quality and the operating conditions of the filtration system.

**[0030]** It will be appreciated that the method of cleaning membranes described above can also be applied to the inside-out filtration process, filtration by suction and other types of membranes, including flat sheet, tubular, spiral wound as well as other configurations.

**[0031]** A number of tests were conducted using different cleaning regimes. These tests are described below.

#### Example 1: Short term tests

**[0032]** A hollow fibre membrane module with a surface area of 33 m<sup>2</sup> (based on OD) was installed in a process illustrated in Figure 1. Filtration was conducted by pressurizing the shell side of the module for 10 minutes and at a flux of 52 L/m<sup>2</sup>/hr. The feed water quality was poor with a turbidity of 35 NTU. At the end of filtration a membrane cleaning procedure was started. The following cleaning strategies were conducted and the cleaning efficiency is compared in Figure 3.

**[0033]** Strategy 1: Permeate backwash only. The cleaning protocol involved the permeate backwash only at a flow rate of 3.2 m<sup>3</sup>/hr and a duration of 15 seconds. Solids were removed by pumping the feed water at a flow rate of 3.5 m<sup>3</sup>/hr from the lower inlet port and sweeping out of the module through valve AV5 for 38 seconds. The TMP kept rising after each backwash, indicating poor backwash efficiency.

**[0034]** Strategy 2: Air scouring and permeate backwash. The cleaning strategy included a pre-aeration for

15 seconds at an air flow rate of 8 m<sup>3</sup>/hr and then the permeate backwash similar to Strategy 1 plus a continued aeration for 15 seconds. The solids were removed by the normal sweep as in Strategy 1. The TMP dropped after such cleans and a better cleaning efficiency was achieved.

**[0035]** Strategy 3: High velocity sweep down. The sequence was air scouring for 15 seconds, gravity drain down of waste (5 seconds), permeate backwash with the shell side valves closed till the pressure at the permeate side reached 480 kPa (20 seconds), then opening the drain valve to achieve a blow-out and high velocity sweep down (10 seconds). Figure 3 shows that such a high velocity sweep-down further recovered TMP and removed the foulant on the membranes. The high velocity sweep not only removed accumulated solids from the module, it also provided further scouring of the membrane surfaces.

**[0036]** Strategy 4: Similar to Strategy 3 with a slightly different time scale: gravity drain for 10 seconds, backwash and pressurization for 30 seconds followed by high velocity sweep down for 5 seconds. Similar effect to Strategy 3 was recorded.

**[0037]** The above strategies were repeated and the results illustrated effectiveness of the high velocity sweep down in removing accumulated solids from module.

#### Example 2: Extended test on effect of high velocity (HV) sweep

**[0038]** An extended test was conducted in the same pilot machine and on the same site as in Example 1. The strategy combining air scouring and permeate backwash (Strategy 2 in Example 1) was used to clean the membranes. Fouling of the membrane was reflected in the TMP rise during a constant flux operation process. The TMP change profile was recorded on a data logger device and Figure 4 illustrates the TMP profile. After three days (October 30 - November 2) TMP rose by 5.5 kPa. Then the control program was changed to allow one high velocity sweep (Strategy 4 in Example 1) for every eight-hours of operation. The TMP was quite stable during the next six days and only a rise of 1 kPa was recorded. On November 8, the special high velocity sweep was removed and the TMP increased rapidly without the fast sweep. The extended test again illustrated the effectiveness of the high velocity sweep in cleaning of membranes.

**[0039]** A further aspect not forming part of the claimed invention relates to an improved gas scouring method where permeate can be withdrawn from both ends of the module. According to this aspect there is provided a method of cleaning a membrane filtration module, said module including at least one elongate membrane positioned in a feed-containing vessel, the membrane having a permeable wall which is subjected to a filtration operation wherein feed containing contaminant matter is applied to one side of the membrane wall and filtrate is

withdrawn from the other side of the membrane wall, the method comprising the steps of:

- a) suspending the filtration operation;
- b) dislodging contaminant matter from said membrane wall into liquid surrounding the membrane by flowing gas bubbles along the one side of the membrane wall, said gas bubbles being formed by feeding gas into said feed-containing vessel through an opening therein.

[0040] Preferably, the opening is positioned laterally of the membrane.

[0041] In the prior art gas or air was introduced into the modules via the bottom port and the permeate taken from the top end only. The details of such a module configuration are described in United States Patent No. 6,156,200.

[0042] In the above examples 1 and 2, we have shown the introduction of gas into a module when the permeate is withdrawn from both ends. Figure 5 illustrates the module configuration and the ports for alternative gas injection. In this configuration, port 12 is connected to the gas source via valve AV9 and the backwash line through valve AV4 is removed. Permeate is withdrawn from one end through port 11.

[0043] There are two choices of introducing gas into the module 7. The first option is to introduce gas into the bottom pot of the module via port 12. Alternatively gas can be injected via shell side feed port 14. This method allows the application of gas scouring to the situation where the permeate is taken from both ends of a module. Figure 6 compares the TMP profile by changing the injection of gas into port 12 or 14. Under the same operating conditions, injecting gas into a different port did not produce any significant effect on the gas scrubbing efficiency.

## Claims

1. A method of cleaning a membrane filtration module (6), said module including at least one membrane (8) located in a feed-containing vessel (7), the membrane (8) having a permeable wall which is subjected to a filtration operation wherein feed containing contaminant matter is applied to one side of the membrane wall and filtrate is withdrawn from the other side of the membrane wall, the method comprising the steps of:

- suspending the filtration operation;
- performing a cleaning process on the membrane wall to dislodge contaminant matter therefrom into liquid surrounding the membrane (8);
- and
- recommencing the filtration operation, wherein the liquid containing the dislodged con-

taminant matter is removed by a high velocity sweep of the feed-containing vessel (7) by forming a gas containing region within said feed-containing vessel (7) on the feedside following said cleaning step;

- sealing the feed-containing vessel (7);
- applying pressure to gas within the gas containing region on the feed side of the membrane to pressurize said gas;
- releasing said pressure by opening the feed-containing vessel (7) to atmosphere so as to cause the pressurized gas to expand and produce said high velocity sweep of the feed-containing vessel.

2. The method of claim 1 wherein said gas containing region is formed partially draining down feed liquid within said feed-containing vessel.
3. The method of claim 1 or 2 wherein the step of applying pressure to gas within the gas containing region to pressurize said gas includes applying a fluid backwash to said membrane (8).
4. A method of cleaning a membrane filtration module (6), said module including at least one membrane (8) located in a feed-containing vessel (7), the membrane (8) having a permeable wall which is subjected to a filtration operation wherein feed containing contaminant matter is applied to one side of the membrane wall and filtrate is withdrawn from the other side of the membrane wall, the method comprising the steps of:

- suspending the filtration operation;
- performing a cleaning process on the membrane wall to dislodge contaminant matter therefrom into liquid surrounding the membrane (8);
- and
- recommencing the filtration operation, wherein the liquid containing the dislodged contaminant matter is removed by a high velocity sweep of the feed-containing vessel (7) by providing a gas containing region within a further vessel coupled to said feed-containing vessel (7);
- sealing the feed-containing vessel (7) and the coupled further vessel as a whole following said cleaning step;
- applying pressure to gas within the gas containing region to pressurize said gas;
- releasing said pressure by opening the feed-containing vessel to atmosphere so as to cause the pressurized gas to expand and produce said high velocity sweep of the feed-containing vessel.

5. The method according to anyone of the preceding

claims wherein the cleaning process includes a fluid backwash of the membrane pores.

6. The method according to claim 5 wherein the fluid backwash includes a liquid backwash. 5
7. The method according to claim 5 or 6 wherein the fluid backwash includes a gas backwash.
8. The method according to any one of the preceding claims wherein the velocity of the high velocity sweep is greater than 0.03 m/sec. 10
9. The method according to any one of the preceding claims wherein the velocity of the high velocity sweep is in the range of 0.3 m/sec to 2.0 m/sec. 15
10. The method according to any one of the preceding claims wherein the cleaning process includes gas scrubbing of a surface of the membrane wall. 20
11. A method according to claim 10 when dependent on claim 1 wherein said gas scrubbing includes dislodging contaminant matter from said membrane wall into liquid surrounding the membrane by flowing gas bubbles along the one side of the membrane wall, said gas bubbles being formed by feeding gas into said feed-containing vessel (7) through an opening in the vessel. 25
12. A method according to claim 11 when dependent on claim 1 wherein the opening is positioned laterally of said membrane (8). 30
13. A method according to claim 10 or 11 wherein the opening provides a feed inlet to said feed containing vessel (7) during said filtration operation. 35
14. A method according to any one of claims 10 to 12 to wherein said gas is fed under pressure into said feed-containing vessel (7). 40
15. The method of any one of the preceding claims wherein the high velocity sweep of the feed-containing vessel (7) is performed periodically in different directions within the vessel during operation of the cleaning method. 45
16. The method of any one of the preceding claims wherein the membrane (8) is a hollow fibre membrane and the filtrate is withdrawn from either or both ends of the hollow fibre membrane during the filtration operation. 50

#### Patentansprüche

1. Verfahren zum Reinigen eines Membranfiltermoduls

(6), wobei das Modul mindestens eine Membran (8), die sich in einem Einsatzgut enthaltenden Behälter (7) befindet, und die Membran (8) eine durchlässige Wand aufweist, die für einen Filtrivorgang genutzt wird, bei dem Einsatzgut enthaltender Fremdstoff auf einer Seite der Membranwand eingespeist und auf der anderen Seite der Membranwand Filtrat abgezogen wird, wobei das Verfahren folgende Schritte umfasst:

Unterbrechen des Filtrivorgangs,  
Durchführen eines Reinigungsprozesses an der Membranwand, um Fremdstoff davon in eine die Membran (8) umgebende Flüssigkeit abzulösen, und  
Wiederaufnehmen des Filtrivorgangs,  
wobei die den abgelösten Fremdstoff enthaltende Flüssigkeit mit Hilfe einer Hochdruckspülung des Einsatzgut enthaltenden Behälters (7) abgetragen wird, und zwar durch:

Bilden eines gashaltigen Bereichs auf der Einsatzgutseite in dem Einsatzgut enthaltenden Behälter (7) nach dem Reinigen,  
Abdichten des Einsatzgut enthaltenden Behälters (7),  
Anlegen von Druck an Gas im gashaltigen Bereich auf der Einsatzgutseite der Membran, um das Gas unter Druck zu setzen,  
Ablassen des Drucks durch Öffnen des Einsatzgut enthaltenden Behälters (7) zur Atmosphäre, damit das Gas expandieren und die Hochdruckspülung des Einsatzgut enthaltenden Behälters bewirken kann.

2. Verfahren nach Anspruch 1, bei dem der gashaltige Bereich durch teilweises Ablassen von Einsatzgutflüssigkeit in dem Einsatzgut enthaltenden Behälter ausgebildet wird.
3. Verfahren nach Anspruch 1 oder 2, bei dem das Anlegen von Druck an Gas in dem gashaltigen Bereich zum Unterdrucksetzen des Gases das Anwenden einer Fluidrückspülung an der Membran (8) umfasst.
4. Verfahren zum Reinigen eines Membranfiltermoduls (6), wobei das Modul mindestens eine Membran (8), die sich in einem Einsatzgut enthaltenden Behälter (7) befindet, und die Membran (8) eine durchlässige Wand aufweist, die für einen Filtrivorgang genutzt wird, bei dem Einsatzgut enthaltender Fremdstoff auf einer Seite der Membranwand eingespeist und auf der anderen Seite der Membranwand Filtrat abgezogen wird, wobei das Verfahren folgende Schritte umfasst:

Unterbrechen des Filtrivorgangs,  
Durchführen eines Reinigungsprozesses an der

- Membranwand, um Fremdstoff davon in eine die Membran (8) umgebende Flüssigkeit abzulösen, und Wiederaufnehmen des Filtriervorgangs, wobei die den abgelösten Fremdstoff enthaltende Flüssigkeit mit Hilfe einer Hochdruckspülung des Einsatzgut enthaltenden Behälters (7) ausgetragen wird, und zwar durch:  
Bereitstellen eines gashaltigen Bereiches in einem weiteren Behälter, der mit dem Einsatzgut enthaltenden Behälter (7) verbunden ist, nach dem Reinigen Abdichten des Einsatzgut enthaltenden Behälters (7) und des damit verbundenen weiteren Behälters als Ganzes, Anlegen von Druck an Gas im gashaltigen Bereich, um das Gas unter Druck zu setzen, Ablassen des Drucks durch Öffnen des Einsatzgut enthaltenden Behälters zur Atmosphäre, damit das Gas expandieren und die Hochdruckspülung des Einsatzgut enthaltenden Behälters bewirken kann.
5. Verfahren nach einem der vorhergehenden Ansprüche, bei dem der Reinigungsprozess eine Fluidrückspülung der Membranporen umfasst.
6. Verfahren nach Anspruch 5, bei dem die Fluidrückspülung eine Flüssigkeitsrückspülung umfasst.
7. Verfahren nach Anspruch 5 oder 6, bei dem die Fluidrückspülung eine Gasrückspülung umfasst.
8. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die Geschwindigkeit der Hochdruckspülung mehr als 0,03 m/s beträgt.
9. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die Geschwindigkeit der Hochdruckspülung im Bereich von 0,3 m/s bis 2,0 m/s liegt.
10. Verfahren nach einem der vorhergehenden Ansprüche, bei dem der Reinigungsprozess eine Gaswäsche einer Oberfläche der Membranwand umfasst.
11. Verfahren nach Anspruch 10, bei dem die Gaswäsche das Ablösen von Fremdstoff von der Membranwand in die Membran umgebende Flüssigkeit umfasst, indem an einer Seite der Membranwand Gasblasen entlangeleitet werden, die durch Einleiten von Gas in den Einsatzgut enthaltenden Behälter (7) über eine Öffnung darin gebildet werden.
12. Verfahren nach Anspruch 11, bei dem die Öffnung seitlich zur Membran (8) angeordnet ist.
13. Verfahren nach Anspruch 10 oder 11, bei dem die Öffnung bei dem Filtriervorgang als Einsatzgut-Einlass für den Einsatzgut enthaltenden Behälter (7) vorgesehen ist.
14. Verfahren nach einem der Ansprüche 10 bis 12, bei dem das Gas unter Druck in den Einsatzgut enthaltenden Behälter (7) eingespeist wird.
15. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die Hochdruckspülung des Einsatzgut enthaltenden Behälters (7) im Verlauf des Reinigungsverfahrens regelmäßig in verschiedenen Richtungen innerhalb des Behälters erfolgt.
16. Verfahren nach einem der vorhergehenden Ansprüche, bei dem es sich bei der Membran (8) um eine Hohlfasermembran handelt und das Filtrat beim Filtriervorgang von einem oder beiden Enden der Hohlfasermembran abgezogen wird.
- ### Revendications
1. Procédé de nettoyage d'un module (6) de filtration sur membrane, ledit module comprenant au moins une membrane (8) située dans un récipient (7) contenant une charge, la membrane (8) ayant une paroi perméable qui est soumise à une opération de filtration pendant laquelle la charge contenant une matière contaminante est appliquée sur un côté de la paroi membranaire et le filtrat est retiré de l'autre côté de la paroi membranaire, le procédé comprenant les étapes consistant :
- à suspendre l'opération de filtration ;  
à réaliser un processus de nettoyage sur la paroi membranaire pour en décoller la matière contaminante dans le liquide entourant la membrane (8), et  
à recommencer l'opération de filtration,  
**étant entendu que** le liquide contenant la matière contaminante décollée est retiré par un balayage à grande vitesse du récipient (7) contenant une charge :
- en formant une région contenant du gaz à l'intérieur dudit récipient (7) contenant une charge du côté charge après ladite étape de nettoyage ;  
en scellant le récipient (7) contenant une charge ;  
en appliquant une pression sur le gaz dans la région contenant du gaz du côté charge de la membrane afin de mettre ledit gaz sous pression ;  
en relâchant ladite pression par mise à l'atmosphère du récipient (7) contenant une charge de sorte à provoquer la dilatation du gaz sous pression et à produire ledit balayage à grande vitesse du récipient contenant

une charge.

2. Procédé selon la revendication 1 dans lequel ladite région contenant du gaz est formée en partie par vidange de liquide de charge à l'intérieur dudit récipient contenant une charge. 5
3. Procédé selon la revendication 1 ou 2 dans lequel l'étape d'application d'une pression sur le gaz dans la région contenant du gaz afin de mettre ledit gaz sous pression consiste à appliquer un rétrolavage par fluide à ladite membrane (8). 10
4. Procédé de nettoyage d'un module (6) de filtration sur membrane, ledit module comprenant au moins une membrane (8) située dans un récipient (7) contenant une charge, la membrane (8) ayant une paroi perméable qui est soumise à une opération de filtration pendant laquelle la charge contenant la matière contaminante est appliquée sur un côté de la paroi membranaire et le filtrat est retiré de l'autre côté de la paroi membranaire, le procédé comprenant les étapes consistant : 15
  - à suspendre l'opération de filtration ; 25
  - à réaliser un processus de nettoyage sur la paroi membranaire pour en décoller la matière contaminante dans le liquide entourant la membrane (8), et
  - à recommencer l'opération de filtration, 30

**étant entendu que** le liquide contenant la matière contaminante décollée est retiré par un balayage à grande vitesse du récipient (7) contenant une charge : 35

  - en créant une région contenant du gaz à l'intérieur d'un autre récipient couplé audit récipient (7) contenant une charge ;
  - en scellant le récipient (7) contenant une charge et l'autre récipient couplé comme un tout après ladite étape de nettoyage ;
  - en appliquant une pression sur le gaz dans la région contenant du gaz afin de mettre ledit gaz sous pression ;
  - en relâchant ladite pression par mise à l'atmosphère du récipient contenant une charge de sorte à provoquer la dilatation du gaz sous pression et à produire ledit balayage à grande vitesse du récipient contenant une charge. 45 50
5. Procédé selon l'une quelconque des revendications précédentes dans lequel le procédé de nettoyage consiste en un rétrolavage par fluide des pores membranaires. 55
6. Procédé selon la revendication 5 dans lequel le rétrolavage par fluide consiste en un rétrolavage par

liquide.

7. Procédé selon la revendication 5 ou 6 dans lequel le rétrolavage par fluide consiste en un rétrolavage par gaz.
8. Procédé selon l'une quelconque des revendications précédentes dans lequel la vitesse du balayage à grande vitesse est supérieure à 0,03 m/s.
9. Procédé selon l'une quelconque des revendications précédentes dans lequel la vitesse du balayage à grande vitesse est de l'ordre de 0,3 m/s à 2,0 m/s.
10. Procédé selon l'une quelconque des revendications précédentes dans lequel le procédé de nettoyage consiste en un lavage de gaz d'une surface de la paroi membranaire.
11. Procédé selon la revendication 10 dans lequel ledit lavage de gaz consiste à décoller la matière contaminante de ladite paroi membranaire dans le liquide entourant la membrane par circulation de bulles de gaz le long d'un côté de la paroi membranaire, lesdites bulles de gaz étant formées en injectant du gaz dans ledit récipient (7) contenant une charge par une ouverture dans le récipient.
12. Procédé selon la revendication 11 dans lequel l'ouverture est positionnée sur le côté de ladite membrane (8).
13. Procédé selon la revendication 10 ou 11 dans lequel l'ouverture ménage une entrée d'alimentation dans ledit récipient (7) contenant une charge durant ladite opération de filtration.
14. Procédé selon l'une quelconque des revendications 10 à 12 dans lequel ledit gaz est injecté sous pression dans ledit récipient (7) contenant une charge.
15. Procédé selon l'une quelconque des revendications précédentes dans lequel le balayage à grande vitesse du récipient (7) contenant une charge est réalisé périodiquement dans des directions différentes à l'intérieur du récipient durant l'utilisation du procédé de nettoyage.
16. Procédé selon l'une quelconque des revendications précédentes dans lequel la membrane (8) est une membrane à fibres creuses et le filtrat est retiré de l'une des deux extrémités de la membrane à fibres creuses ou des deux durant l'opération de filtration.



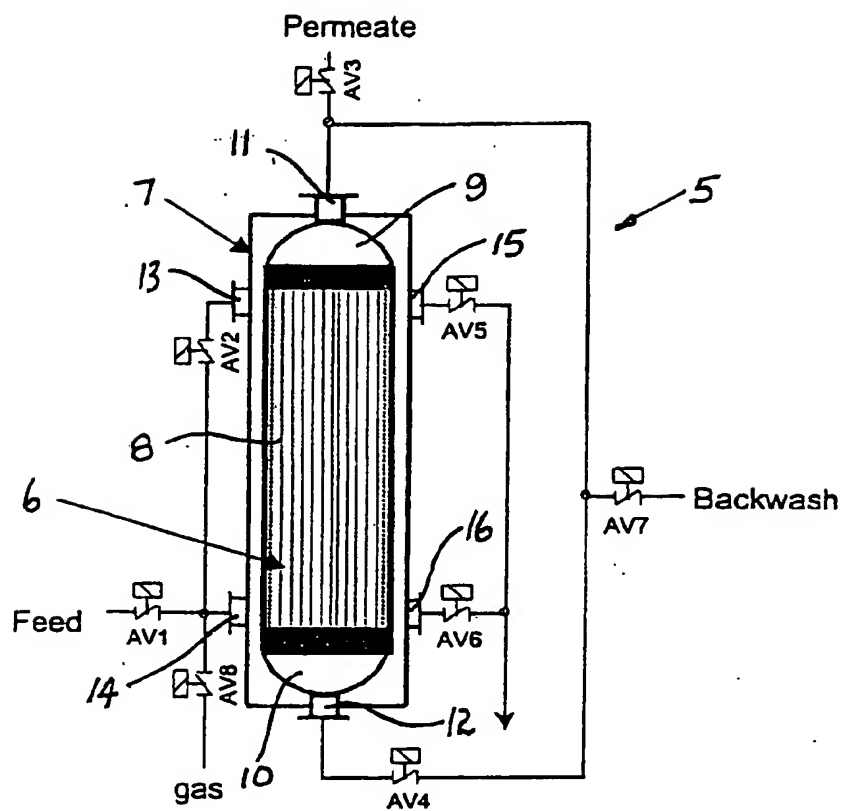


Figure 1 Membrane Module Assembly

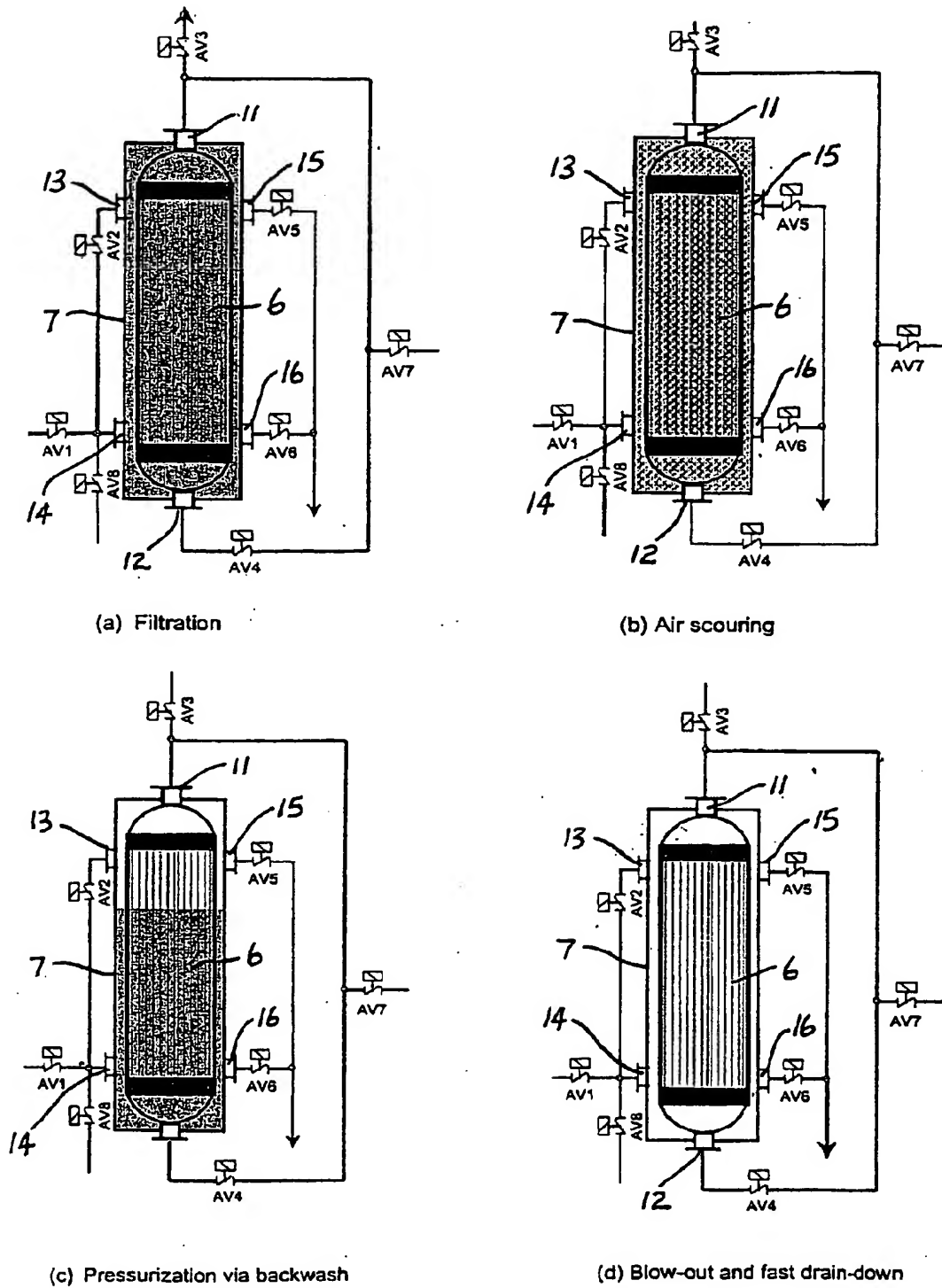


Figure 2 Membrane Cleaning Sequence

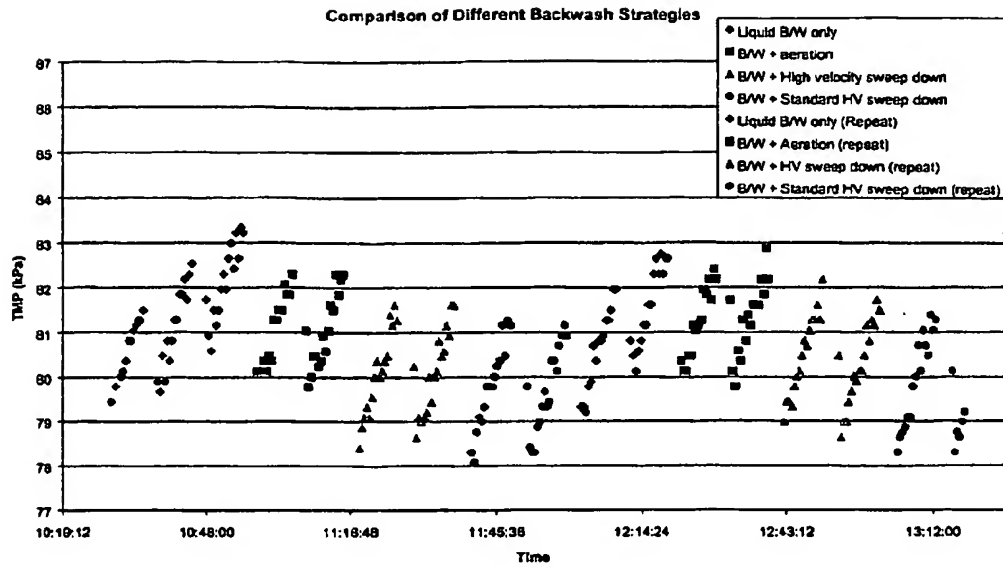


Figure 3 Cleaning Efficiency of Different Strategies

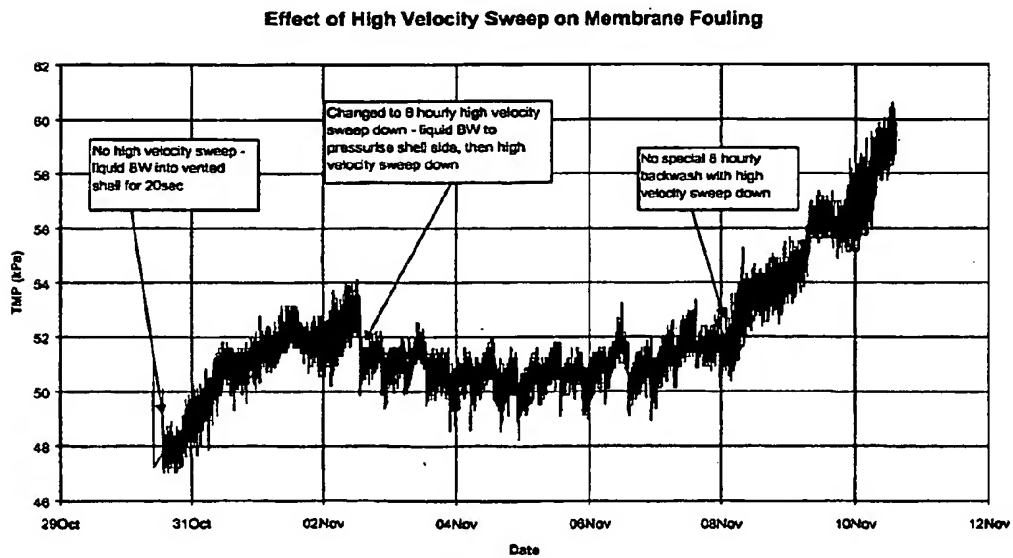


Figure 4 Effect of High velocity Sweep on Membrane Cleaning

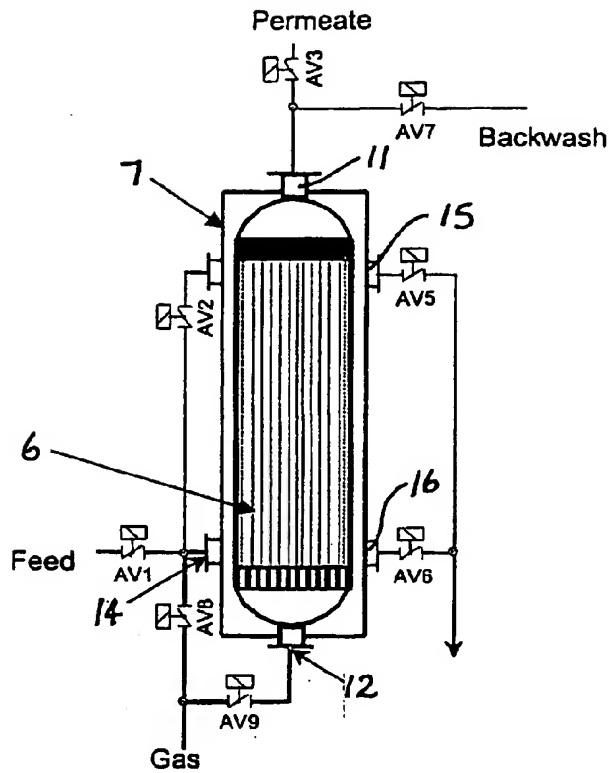


Figure 5 Alternative Air Injection

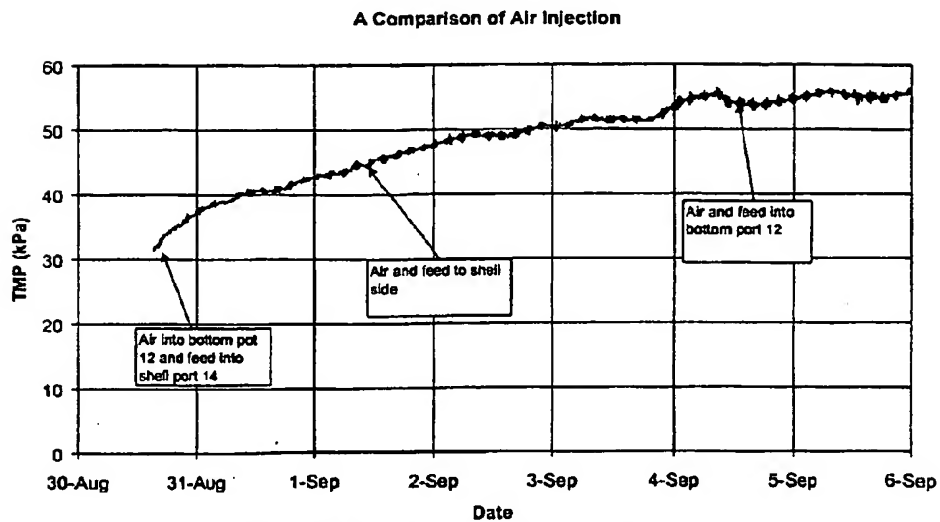


Figure 6 Effect of Alternative Air Injection on Scrubbing Efficiency

**REFERENCES CITED IN THE DESCRIPTION**

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